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Fiscal multipliers in Ireland using FIR-GEM model

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Abstract: This article employs the newly developed FIR-GEM model to compute fiscal multipliers in Ireland for the main tax-spending policy instruments, namely government consumption, public investment, public wages, public transfers, consumption, capital and labour taxes. We focus on the short run fiscal multipliers as a measure to evaluate the effect of a temporary fiscal stimulus policy over three years. We find that the size of output multipliers crucially depends on the openness of the Irish economy and the method of fiscal financing employed. Our main results indicate that spending increases or tax cuts increase Irish GDP but Irish fiscal multipliers are relatively smaller in magnitude due to the openness of the economy. That is the increase in aggregate output is partly offset due to the negative effect of a fiscal stimulus in the Irish external balance. A fiscal expansion via spending increases or tax cuts results in a compositional change in aggregate Irish output. The positive effects on aggregate output come mostly from the stimulative effects induced in the non-tradable sector while the tradable sector remains unaffected or reduces in size. A fiscal stimulus is likely to crowd out exports and crowd in imports; this results in a deterioration in Irish trade balance. Magnitude-wise short run spending multipliers are consistently higher than short run tax multipliers. The highest fiscal multiplier effect is as a result of spending on public investment and government consumption. A fiscal stimulus via spending and consumption tax cuts have a higher effect on impact but can put upward pressures on domestic prices vis-à-vis the rest of the world and lead to a deterioration in Irish international competitiveness in the longer run. A fiscal stimulus via income tax cuts take more time to materialize and has a smaller effect on impact but the stimulus can reduce production costs and prices. This improves the international competitiveness of the Irish economy and has a more positive effect over the longer-term.

Acknowledgements: FIR-GEM was developed as part of the joint research programme "Macroeconomy, Taxation and Banking" between the ESRI, the Department of Finance and Revenue Commissioners and I am grateful for many helpful comments of the programme steering committee and the Department of Finance. I would like to especially thank Martina Lawless, Kieran McQuinn and Diarmaid Smyth for many insightful suggestions and comments. I would also like to thank Adele Bergin, Abian Garcia-Rodriguez, Ilias Kostarakos and Conor O'Toole and participants at the Quarterly Macro Meet up at the ESRI for useful comments. The views expressed herein are my own and do not necessarily reflect the views of ESRI, Department of Finance and the Revenue Commissioners.

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Abstract

This article employs the newly developed FIR-GEM model to compute fiscal multipliers in Ireland for the main tax-spending policy instruments, namely government consumption, public investment, public wages, public transfers, consumption, capital and labour taxes. We focus on the short run fiscal multipliers as a measure to evaluate the effect of a temporary fiscal stimulus policy over three years. We find that the size of output multipliers crucially depends on the openness of the Irish economy and the method of fiscal financing employed. Our main results indicate that spending increases or tax cuts increase Irish GDP but Irish fiscal multipliers are relatively smaller in magnitude due to the openness of the economy. That is the increase in aggregate output is partly offset due to the negative effect of a fiscal stimulus in the Irish external balance. A fiscal expansion via spending increases or tax cuts results in a compositional change in aggregate Irish output. The positive effects on aggregate output come mostly from the stimulative effects induced in the non-tradable sector while the tradable sector remains unaffected or reduces in size. A fiscal stimulus is likely to crowd out exports and crowd in imports; this results in a deterioration in Irish trade balance. Magnitude-wise short run spending multipliers are consistently higher than short run tax multipliers. The highest fiscal multiplier effect is as a result of spending on public investment and government consumption. A fiscal stimulus via spending and consumption tax cuts have a higher effect on impact but can put upward pressures on domestic prices vis-à-vis the rest of the world and lead to a deterioration in Irish international competitiveness in the longer run. A fiscal stimulus via income tax cuts take more time to materialize and has a smaller effect on impact but the stimulus can reduce production costs and prices. This improves the international competitiveness of the Irish economy and has a more positive effect over the longer-term.

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Highlights

- Irish fiscal multipliers are expected to be smaller in magnitude than most EU countries due to the degree of openness of the domestic economy and the large influence of the tradable sector.

- Spending multipliers are consistently larger than tax multipliers in the short run.

- In terms of the effect on GDP in the first year, the most effective Irish fiscal instruments are as follows: public investment, government consumption, consumption taxes, capital taxes, public transfers, public wages and, finally, labour taxes.

- A fiscal stimulus is very likely to affect the composition of GDP by augmenting the non-tradable sector vis-à-vis the tradable sector.

- A spending stimulus may result in a negative effect on the Irish external balance by causing a deterioration in the competitiveness of the Irish economy.

- Income tax cuts have a smaller effect on the external balance as they reduce productions costs and prices which improves the competitiveness of the Irish economy and induce long lasting effects on GDP.

- The method of fiscal financing is crucial for the efficacy of a fiscal stimulus. A spending stimulus financed via tax increases mitigates the positive effect on GDP.

1. Introduction

The European debt crisis in 2008 led several Eurozone countries to implement fiscal consolidation policies. After multiyear fiscal consolidation programmes, which aimed at dealing with debt sustainability issues, most European countries have launched growth enhancing fiscal policies.

In light of this economic environment, policy and academic interest in fiscal multipliers has increased. By definition, multipliers[3] constitute key macroeconomic indicators of the potential effects of fiscal policy changes on economic activity. As such, they can be thought of as tools for designing well executed and effective fiscal policies by policymakers. Although economists have not reached a consensus on the size of fiscal multipliers (see e.g. Batini et al. (2014) and Leeper et al. (2017)), the quantification of fiscal multipliers can provide fiscal policymaking with a quantitative and qualitative ranking of the effectiveness of fiscal instruments. The aim of this article is to employ a Small Open Economy Dynamic Stochastic General Equilibrium (SOE-DSGE) model calibrated for Ireland to quantify the main fiscal multipliers.

Ireland has implemented a front-loaded expenditure-based fiscal consolidation package via cutbacks in public wages and investment (for more details on the Irish fiscal consolidation see McCarthy (2015) and Larch et al. (2016)). After 2014 Ireland succeeded in stabilizing its public finances and reducing sovereign premia close to their historical average. At the same time Irish economic activity has grown significantly with growth rates outpacing the rest of the Euro Area. Going forward, Irish fiscal policy faces challenging trade-offs between promoting growth enhancing fiscal policies while keeping public finances stable and maintaining competitiveness.

Any fiscal policy analysis should take into account the specific structure of the Irish economy. One of the most distinct structural characteristics of the domestic economy is its degree of openness. This is reflected in a number of key Irish macroeconomic aggregates. In particular:

- the larger size of the tradable sector vis-à-vis the non-tradable sector; the share of gross value added in the tradable sector averaged 59% over the period 2001-2014.
- The export-orientation of the tradable sector;[4] for example the gross value added component of exports to GDP averaged 52% between 2001and 2011[5] and
- The reliance of domestic consumption and production on imports and the large trade balance. This averaged 14% as a share of GDP between 2001 and 2014.

Macroeconomic theory and empirical evidence finds that fiscal policy is heavily influenced by changes in the sectoral composition of output and adjustments in the trade balance[6]. Due

[3]For example, the output multiplier is defined as the impact of a discretionary fiscal policy change on output.
[4] For more details on the composition of the export-oriented Irish tradable sector see Barry and Bergin (2012) and (2018).
[5] We employ data from OECD-TiVA database which provide data on exports in value added (time series Domestic value added embodied in foreign final demand "FFD_DVA"). Irish data are only available for 2001-2011.

to the exceptional openness of the Irish economy, the channel through which fiscal policy affects the trade balance has a significant effect on the size of fiscal multipliers.

Ireland is a member of a monetary union, which means that the main macroeconomic tool available to the Government is national fiscal policy. Fiscal data show that the Irish fiscal sector is relatively small compared with most Eurozone countries. For example, Irish government expenditures and tax revenues as shares of GDP are among the lowest within Eurozone countries; e.g. they amount to 38% and 33% of GDP[7] over 2001-2014 in Ireland while the associated Eurozone averages are 48% and 45% respectively.

In this article, we compute the short run fiscal multipliers for the main tax-spending instruments in the Irish economy, namely, spending instruments are government consumption, public investment, public wage bill and public transfers while tax instruments are consumption, labour and capital tax.

Our primary aim is to measure the short run effect on Ireland's key macroeconomic variables of temporary increases (cuts) in spending (tax) instruments *ceteris paribus*. In particular, we simulate a fiscal stimulus policy that is implemented in a "normal" times mimicking the current economic conditions in Ireland. Also, fiscal stimulus is temporary (lasts only for three years) meaning that we abstract from more permanent fiscal reforms. This allows us to isolate the short run impact of each fiscal policy instrument on the Irish economy without assuming further fiscal changes that can have important quantitative implications on our results.

We perform robustness analysis on the structural characteristics that can affect qualitatively and quantitatively the size of fiscal multipliers in Ireland. These include the degree of openness, alternative fiscal financing methods and the sensitivity of the international nominal rate at which Ireland borrows to public debt dynamics.

The main results are as follows: first a fiscal stimulus via spending produces more output than a stimulus via tax cuts at least in the short run; that is spending multipliers are consistently larger than tax multipliers. Second, in terms of the magnitude of the impact, a stimulus conducted through increased public investment results in the largest impact on GDP in the first year of the shock. The next biggest impact is through government consumption with capital tax and consumption tax cuts. Third, fiscal policy affects the composition of aggregate output. The fiscal stimulus works solely through the non-tradable sector while the tradable sector remains unaffected or contracts in size. The latter is crucial in the Irish case where the tradable sector is significantly larger than the non-tradable sector. For that reason the size of output multipliers in Ireland are expected to be smaller than in most Euro Area countries. Fourth, fiscal expansion via spending is expected to have a negative effect on the competitiveness of the Irish economy. Our results show a deterioration of the Irish external

[6]For example, Monacelli and Perrotti (2006) find empirical evidence that a rise in government consumption causes a trade balance deficit using a sample of OECD countries while they explain this evidence by developing a theoretical model. Benetrix and Lane (2010) find empirical evidence that fiscal policy has an impact on sectoral composition of output. For a detailed review see Lane (2010).

[7] We also express Irish fiscal aggregates as GNI shares, since GDP and GNI differ by 15% on average over 2001-2014. Although the gap between Eurozone averages and Ireland closes, Irish fiscal aggregates remain amongst the lowest within Eurozone countries, for example government expenditures and tax revenues amount to 45% and 39% in Ireland.

balance in the early years of the post stimulus era; that is the fiscal stimulus is likely to crowd out exports and at the same time crowd in imports. Fifth, income tax cuts induce a smaller effect on the Irish external balance. Capital and labour tax cuts are expected to reduce production costs and prices in Ireland vis-à-vis the rest of the world leading to an improvement in domestic competitiveness. As such, a fiscal expansion via tax cuts induces supply-side effects that take time to materialize (i.e. multipliers are smaller in the short run) but their effects are long lasting.

In what follows, we first describe the model in an informal setup. Second, we compute fiscal multipliers in Ireland. Then, we analyse the fiscal transmission mechanism in the Irish economy. Finally, we perform a robustness analysis to highlight the key determinants of the size of multipliers in the Irish case.

2. Informal description of the model

This section introduces FIR-GEM developed in Varthalitis (2019) in an informal setup. FIR-GEM is a SOE-DSGE with a rich fiscal sector calibrated for the Irish economy. This model is designed as a fiscal policy toolkit for Ireland, and thus contains several key features so as to resemble the structure of the Irish economy and be suitable for fiscal policy analysis: (a) distinction between tradable and non-tradable production sectors; (b) sector-specificity of factor inputs; (c) heterogeneous agents; (d) empirically relevant nominal and real frictions; (e) delegated monetary policy (Ireland is a member of a currency union) and independent national fiscal policy and (f) an explicit fiscal sector with a rich menu of spending-tax instruments and a public production function which produces welfare- and productivity-enhancing public goods and services.

This model is based on microeconomic foundations and economic agent's intertemporal choice. The general equilibrium framework captures the interaction between policy actions and private agent's economic behaviour (for example domestic households, firms and the rest of the world). These features are vital for fiscal policy analysis. Fiscal policymaking can utilize a rich menu of tax and spending instruments that could result in a wide range of macroeconomic aggregate and sectoral effects. Fiscal actions do not only affect private agents' current economic decisions but their economic behaviour over time (intertemporal choices) by influencing their expectations about future fiscal policy[8]. These issues make fiscal policy analysis a complex task (see Leeper (2010)). To evaluate and rank alternative fiscal policies research economists should take into account an explicit analysis of the structure of the economy, private agent's expectations and the dynamic adjustment of their economic behaviour to those fiscal policies.

The model consists of three types of economic agents: households, firms and a government. As regards households, we incorporate two type of households. First, forward-looking optimizing agents which have access to domestic and international financial and

[8]For example, an increase in public spending today may be accompanied by an increase (decrease) in at least one of the tax (spending) instruments in the future to close the government budget. Which instrument will bear the fiscal adjustment in the future will shape private expectations and eventually macroeconomic outcomes.

capital markets while receiving dividends from domestic firms. These households are referred to as "Ricardians" or "Savers". Second, financially constrained agents which do not have access to financial and capital markets, that is they live hand to mouth and each period consume their after tax disposable income. These households are referred to as "non-Ricardians" or "non-Savers". The introduction of the latter type of households in the model has non trivial effects in the transmission mechanism of fiscal policy actions (see e.g. Gali et al. 2007, Cespedes et al. 2011 and Leeper et al. 2017). Non-Savers are relatively more prone to changes in government expenditures or/and taxes since they cannot smooth out changes in their disposable income over time. Both types of households provide labour services to the three sectors of the economy, namely tradable, non-tradable and public sectors while they optimally allocate hours worked among these sectors. Both type of households pay consumption and income taxes[9] and receive household-specific public transfers.

We distinguish between two sectors of production, namely the tradable and non-tradable production. Our calibration implies that the home tradable sector is larger vis-à-vis the non-tradable sector. Furthermore, the home tradable sector is export-oriented which means that the larger share of production in this sector is exported to the rest of the world while the domestic absorption of tradable goods is limited. Domestic production of both tradable and non-tradable goods relies heavily on imports from the rest of the world. The home tradable and non-tradable firms rent capital services and hire labour services from households to produce sectoral outputs. Finally, we allow public goods and services to be productivity enhancing in both sectors (see below).

Firms in the public sector utilize goods purchased from the private sector, public employment and public capital to produce a public good that provides both welfare-enhancing and productivity-enhancing services. The associated public spending inputs are set exogenously by the government.

As Ireland is member of the Eurozone we adopt a monetary policy regime where the nominal exchange rate is fixed and there is no monetary policy independence (this mimics membership in a currency union). Under this economic environment, the only macroeconomic tool available is fiscal policy. The present model incorporates a rather rich menu of fiscal policy instruments. In particular, the government has four spending instruments at its disposal, namely government consumption, public investment, public wages and agent-specific public transfers and three tax instruments, namely consumption, labour and capital taxes. In addition, the government can issue domestic and foreign public debt (which along with taxes levied on households) are used to finance public expenditures. We adopt a rule-like approach in that fiscal policy is conducted via simple and implementable fiscal policy rules. As in e.g. Schmitt-Grohe and Uribe (2005) and (2007) "simple" and "implementable" means that policy can easily and effectively be communicated to the public; that is the policy instrument reacts to a small number of easily observed macroeconomic indicators. Here, all the main tax-spending instruments are allowed to react to the public debt to GDP ratio and the deficit so as to ensure fiscal sustainability. Most European countries set

[9] Notice that Ricardians/Savers earn income from labour and capital, thus pay labour and capital taxes while non-Ricardians/non-Savers earn income only from labour so pay only income taxes.

their policy by following some type of fiscal rules so this is an empirically relevant assumption (see European Commission 2012).

3. Fiscal multipliers for Ireland

3.1.Definition

Fiscal multipliers can be measured in several ways. Following e.g. Zubairy (2014) and Leeper et al. (2017), we focus on present-value multipliers which embody the full dynamics of exogenous fiscal actions and discount future changes in macroeconomic variables. For example the first year multiplier is defined as the ratio of the change in Irish GDP to a discretionary change in government spending or tax revenues. Full technical details are provided in Varthalitis (2019).

3.2.Main fiscal stimulus scenario

In this section we develop our main fiscal scenario. To compute the short run fiscal multipliers presented in Tables 1-3 below we simulate a fiscal stimulus scenario. We follow the related literature, e.g. Kilponen et al. (2016), and focus on a temporary fiscal change in a particular spending or tax instrument. In particular, we assume that the Government increases (reduces) a spending (tax) instrument over the next three years, while, from the fourth year and onwards the spending (tax) instrument returns back to its pre stimulus value. For reasons of comparison among different fiscal instruments, the size of fiscal shock is normalized to represent an increase in government expenditures or a decrease in total tax revenues equal to 1% of pre stimulus GDP over three years. At the same time to ensure fiscal sustainability, Irish fiscal policy is set such that total public transfers react to deviations in the debt-to-output ratio from its target level (for alternative fiscal financing schemes see section 5.3. below). We examine one fiscal instrument at a time while the remaining fiscal policy instruments are kept constant at their pre stimulus values. This scenario enables us to isolate the fiscal effect on key macroeconomic variables of discretionary fiscal policy changes by fiscal policy instrument *ceteris paribus*. [10]

3.3.GDP multipliers

Table 1 computes the present value GDP multipliers by fiscal policy instrument under the fiscal scenario developed in section 3.2. In particular, in the second row we compute the implied increase in GDP produced by an increase in government consumption that lasts over three years. Our model suggests that a 1% increase in government consumption over the next three years produces a 0.59% additional GDP in the first year while the cumulative discounted change is equal to 0.42% and 0.34% in the second and third year respectively. A 1% increase in government investment (see in third row) over three years produces 0.62%, additional GDP in the first while the discounted cumulative change is 0.37% and 0.25%

[10] This fiscal scenario should be contrasted to more permanent fiscal changes, i.e. fiscal reforms. In the latter case, fiscal instruments may change permanently and the macroeconomic implications depend on several factors such as the method of fiscal financing, the timing of fiscal change etc. For an overview see Leeper (2010).

second and third year respectively. The 1% increase in public wage bill results in 0.16% additional GDP in the first year, while the increase in GDP in the second and the third year is quantitatively small (see fourth row). A 1% increase in public transfers increase GDP by 0.24% and 0.07% in the first and the second year, while, the effect on GDP turns to negative in the third year.[11] A 1% decrease in tax revenues arising from a decrease in the consumption tax produces 0.51% additional GDP in the first year, while, the cumulative discounted change is equal to 0.2% and 0.08% in the second and third year respectively. A 1% decrease in tax revenues arising from a decrease in capital tax produces 0.44% additional GDP in the first year, the cumulative discounted GDP change reduces to 0.07% in the second year and turns to negative in the third year. This is expected due to the temporary nature of the fiscal stimulus, i.e. a temporary capital tax cut will have a positive effect in the first year but since economic agents anticipate that in the fourth year capital tax will return back to its pre-stimulus value (i.e. increase) this is expected to mitigate any medium run positive effects. Finally, a 1% decrease in tax revenues arising from a decrease in labour tax produces 0.09% additional GDP in the first year, while the cumulative discounted change increases in the second and the third year to 0.2% and 0.29%. Thus labour tax cuts are expected to take more time to transmit in the economy, as we show below, initially they boost employment and investment and then these increases are reflected in GDP. In the next paragraphs we summarize some key results and provide some economic intuition.

Table 1: Present Value Output multipliers by fiscal instrument

Description	1st year	2nd year	3rd year
Gov. consumption	0.59	0.42	0.34
Gov. investment	0.62	0.37	0.25
Public wages*	0.16	0.06	0.01
Public transfers	0.24	0.07	-0.02
Consumption tax	0.51	0.2	0.08
Capital tax	0.44	0.07	-0.05
Labour tax	0.09	0.2	0.29

Note*: We report the net effect on aggregate output.

Some key results arising from Table 1 are the following: First, spending multipliers are in general higher in the short-run than tax multipliers which is consistent with findings in other empirical and theoretical studies (for a collection of findings see in Batini et al. (2014)). Impact multipliers indicate that the stimulative effects of a fiscal expansion are larger in the case of government consumption and public investment. In particular, government

[11] This happens for several reasons. First, note that in our main fiscal scenario public transfers are used to react to debt to output ratio. Thus total public transfers gradually reduce to ensure fiscal sustainability. Second, an increase in public transfers affects "Savers" and "Non Savers" asymmetrically. It boosts consumption of "Non Savers" since they do not have access to financial and bonds markets, thus, they consume their whole disposable income. On the other hand, "Savers" can smooth their consumption plans, and since they anticipate a reduction in public transfers they save the additional income to compensate for the future loss and keep their consumption constant. The combined effect results in a negative multiplier in the third year (though very small quantitatively).

consumption and public investment impact multipliers are equal to 0.59 and 0.62. The latter values tend to be smaller than spending multipliers estimates that have been reported for the Euro Area[12]. The relatively smaller output effect of a government spending stimulus can be attributed to several key structural characteristics of the Irish economy namely its openness, the relatively large influence of the tradable sector in aggregate economy, the reliance of the Irish economy on imports and the sensitivity of sovereign risk premia to public debt dynamics (see analysis in sections 5.1. and 5.2. below).

Our model implies that households and the government can allocate their purchases among domestic tradable, non-tradable and imported goods. Thus, a component of government spending may fall in imports through a direct and an indirect channel. First, the government can directly purchase goods from domestic sources which are produced using imports or indirectly increase economic agents' incomes who in turn spend part of this additional income on imported goods. The magnitude of this depends on the effect of fiscal changes on the trade balance. Our results suggest that a fiscal stimulus via government spending crowds out exports which combined with the large size and the export-orientation of the Irish tradable sector can explain the smaller magnitude of Irish spending multipliers. This is reflected in the dynamic responses of the real exchange rate[13], the terms of trade[14] and the trade balance[15] which imply that the international competitiveness of the Irish economy deteriorates (see section 4 below for an analysis on the fiscal transmission mechanism).

Regarding tax multipliers, a cut in consumption tax causes a positive domestic demand effect in the Irish economy. Aggregate private consumption increases; however as explained above part of it results in larger imports. The increased domestic demand boosts the non-tradable sector which leads to upward pressures in factor inputs in both sectors and finally in domestic prices. The international competitiveness of the Irish economy deteriorates, exports are crowding out and the tradable sector contracts vis-à-vis the non-tradable sector.

Temporary income tax cuts (capital and labour) take relatively more time to accumulate and produce consistently lower impact multipliers in terms of magnitude. Income tax cuts have both demand- and supply-side effects and stimulate private consumption and investment and in almost all cases employment. In addition, income taxes affect directly equilibrium factor prices meaning that they reduce marginal costs especially in the tradable sector. The reduction in prices in the tradable sector improve Irish international competitiveness. As a result, Irish exports increase under both income tax cuts while the trade balance decreases less than in all the other cases.

3.4.Comparison with other Irish fiscal multipliers estimates

In this section we discuss other estimates for the Irish fiscal multipliers produced using different models and methodologies. As it is expected estimates for Irish fiscal multipliers vary widely across models and methodologies, for example, government consumption first

[12]See Kilponen et al. (2016) for a comparison of fiscal multipliers across models and countries in Europe.
[13]The real exchange rate is defined as the relative price of foreign goods to domestic goods. An appreciation of the real exchange rate implies that foreign goods become more expensive vis-à-vis domestic goods.
[14]The terms of trade is defined as the ratio of exports' prices to imports' prices. A decrease in the Irish terms of trade implies that Irish exports become cheaper vis-à-vis imports.
[15]The trade balance is defined as the value of exports minus the value of imports.

year multipliers range from 0.33 in Barrell et al. (2012) to 1.9 in Clancy et al. (2016). Although a thorough comparison across models and methodologies is beyond the scope of this article in Table 4 in the appendix we present an overview of the multipliers estimated for Ireland. FIR-GEM spending multipliers lie closer to the lower estimates that have been found in the literature mostly due to trade openness and the large influence of the Irish tradable sector, flexibility in labour and product markets and sensitivity of sovereign premia with respect to Irish debt dynamics[16]. FIR-GEM tax multipliers are closer to multipliers computed with HERMES-13 (see Bergin et al. (2013)), for example HERMES-13 estimates the first year income tax multiplier to be 0.4.

To measure the compositional effects of fiscal stimulus in the Irish economy we compute multipliers for other key Irish macroeconomic variables in the next section.

3.5.Other key multipliers

So far we have quantified a single measure to gauge the effects of discretionary fiscal actions, namely the aggregate output multiplier. Although the output multiplier enables fiscal policymakers to see the overall effects on the Irish economy, usually it is useful to quantify multipliers of other key endogenous macroeconomic variables. This is of particular importance when fiscal policy aims to target specific sectors or/and cohorts of the population when forming its policy. It is well known that different fiscal policy instruments can have different implications in different sectors and/or for agents of the economy (see e.g. Leeper (2010) and Christiano et al. (2018)). The openness and the export/import-oriented nature of the Irish economy make this analysis essential for designing well executed fiscal policies.

To assess these effects we quantify in Tables 2 and 3 fiscal multipliers for the sectoral outputs, consumption, investment, agent-specific consumption and net exports by fiscal instrument (spending and tax respectively). We compute these multipliers implementing the same fiscal scenario analysed in section 3.2. To save space we only present the impact multiplier for each endogenous variable. Tables 2 and 3 illustrate that the stimulative effects on aggregate output solely comes from the non-tradable sector; whereas fiscal stimulus leaves the tradable sector unaffected and this holds across all available fiscal instruments. This can be explained by the net exports[17] multiplier computed in the last rows of Table 2 and 3. A fiscal stimulus causes a decrease in the trade balance. This can be explained by several reasons including the reliance of the Irish economy on imports, the depreciation of the real exchange rate and the resulting deterioration in Irish international competitiveness. That is, a relatively large share of the additional disposable income that may arise through spending hikes or tax cuts will result in higher levels of imports, while Irish exports become relatively more expensive.

[16]For more details see the robustness analysis in Varthalitis (2019).
[17]Net exports are defined as exports minus imports weighted by the associated relative prices.

Table 2: Spending Impact Multipliers				
Variable	Govt. consumption	Govt. Investment	Public wages	Public Transfers
Output	0.59	0.62	1.16	0.24
Tradable	-0.01	0.01	0.01	0.02
Non-tradable	0.6	0.61	0.15	0.22
Aggregate consumption	0.03	0.07	0.187	0.27
"Savers" consumption	-0.1	-0.1	0.004	0
"Non-Savers" consumption	0.12	0.17	0.183	0.27
Aggregate Investment	0.22	0.2	0.15	0.23
Investment in the tradable	-0.1	-0.12	0.01	0.02
Investment in the non-tradable	0.32	0.32	0.14	0.21
Net Exports	-0.6	-0.59	-0.14	-0.2

Table 3: Tax Impact Multipliers			
Variable	Consumption Tax	Capital Tax	Labour Tax
Output	0.51	0.44	0.09
Tradable	0.01	0.01	-0.03
Non-tradable	0.49	0.44	0.12
Aggregate consumption	0.86	0.19	0.17
"Savers" consumption	0.4	0.03	0.04
"Non-Savers" consumption	0.46	0.16	0.13
Investment	0.16	0.94	0.09
Investment in the tradable	-0.07	0.56	0.06
Investment in the non-tradable	0.23	0.38	0.04
Net Exports	-0.46	-0.41	-0.15

In the next section, we discuss in detail the fiscal transmission mechanism in the Irish economy of each fiscal instrument under the main fiscal scenario.

4. Fiscal policy transmission mechanism

In this section we present the impulse response functions of the key endogenous variables of the model to temporary discretionary fiscal changes in the main fiscal policy instruments in order to shed light on the transmission channel of fiscal policy changes in the Irish economy. To do this, we implement exogenous fiscal shocks to the main tax-spending instruments (the magnitude of fiscal shocks is normalized to 1% on impact of their baseline value).[18] Due to the structure of our model which is designed to resemble some key structural characteristics of the Irish economy, the sign and the magnitude of the effect as well as the transmission mechanism of the fiscal stimulus differs between the tradable and the

[18] In addition, for illustrative purposes we allow each fiscal instrument to return gradually to its pre-stimulus value after the fiscal shock, while in section 3 fiscal instruments return to their pre stimulus value in the fourth year.

non-tradable sector. Our results indicate that a temporary fiscal stimulus can increase Irish GDP; however this works solely through the non-tradable sector while the tradable sector shrinks. This is highly dependent on the degree of openness of the Irish economy.

4.1.Spending increases

We start by studying the effects of a temporary discretionary fiscal change in government consumption. Figure 1 illustrates the dynamic responses of the key Irish macroeconomic variables when we implement an exogenous shock to government consumption. Fiscal stimulus via government consumption causes an increase in Irish GDP. This aggregate increase can solely be attributed to the stimulative effects that an increase in spending induces in the non-tradable sector (see the impulse response of the non-tradable output) while the tradable sector contracts initially and eventually increases (see the impulse response of the tradable output). However, the effects on the tradable sector are quantitatively small. Since the government fiscal shock results in different sectoral responses, we organize our discussion on the fiscal transmission mechanism around the two sectors, i.e. non-tradable and tradable.

Regarding the non-tradable sector, firms increase production of the non-tradable good to meet the increased domestic demand stemming from government consumption stimulus. To produce this additional output, they rent physical capital and hire labour, i.e. private investment and hours worked in the non-tradable sector increase. The increased demand for productive factor inputs in the non-tradable sector causes an increase in the associated factor prices, i.e. private wages and return on physical capital, which subsequently lead to upward pressures in the sectoral price of the non-tradable sector. The increase in the relative price of the non-tradable sector implies a deterioration in the international competitiveness of the Irish economy vis-à-vis the rest of the world. This also can be seen by the impulse response of the real exchange rate. A decrease in the real exchange rate (i.e. a real appreciation) means that foreign prices decrease vis-à-vis domestic prices. This brings us to the discussion of the effect on the tradable sector.

The tradable sector contracts vis-à-vis the non-tradable sector. By construction the government allocates its expenditures both in home produced and imported goods. The impulse response functions show that government consumption crowds out exports while crowds in imports. As a result the trade balance deteriorates in response to a positive government consumption shock. This negative effect on the Irish trade balance reverses any positive effect from the fiscal stimulus on tradable production. As a result, factor inputs shrink and this exerts downwards pressure on sectoral factor prices. This reduction in factor prices gradually improves the terms of trade and shifts back resources to the tradable sector once the fiscal stimulus comes to an end; thus tradable output moves slightly upwards however, this increase is quantitatively small.

The effect of the fiscal stimulus on aggregate private consumption depends on the weighted response of “Savers” and "Non-Savers" consumption. The fiscal stimulus causes a

negative wealth effect on "Savers". This works as follows, higher government consumption increases the debt-to-output ratio in response to the deviation of debt from its target level fiscal policy reduces public transfers. Since "Savers" can smooth their lifetime consumption path through borrowing/lending, they reduce current consumption, to compensate for the future income loss caused by reduction in public transfers. On the other hand, "Non-Savers" live hand to mouth which means that they consume any additional temporary income produced by the fiscal stimulus. As a result they increase current consumption over the fiscal stimulus period while they decrease future consumption, i.e. once fiscal stimulus comes to an end and public transfers starting to react to debt.

[Figure 1 here]

Similarly, Figure 2 illustrates the dynamic effects on Irish macroeconomic variables of a discretionary temporary increase in public investment. As it is expected, the transmission channel is similar to the case of a policy intervention via government consumption[19]. In the short run the qualitative and quantitative effects are almost identical with those of an increase in government consumption. However, we observe some quantitative differences in the medium run, mainly because public investment increases the public capital stock; thus, the productive effects of public investment are more persistent and long lasting. This is inline with results in Hickey et al. (2018) who also find a prolonged effect on GDP as a result of a persistent increase in government investment.

[Figure 2 here]

Figure 3 illustrates the dynamic effects on the Irish macroeconomic variables from an increase in the public wage bill which in our model specification implies an exogenous increase in public wages. As with previous spending instruments, an increase in public wages boosts aggregate domestic output[20]; however the magnitude and transmission mechanism through which a public wage raise affects the Irish economy differs from the previous spending categories. An increase in public wages implies a positive change in the disposable income of both types of households[21] as a result current aggregate consumption increases. As expected, the effect on private consumption is higher in magnitude for "non-Savers" due to their financial constraints. The increase in public wages and in private consumption fuel upward pressures in private sector wages and prices. This hurts the international competitiveness of the Irish economy vis-à-vis the rest of the world relatively more than the

[19] In the present model both government consumption and investment are used as productive inputs in public production.
[20]The quantitatively significant effect on aggregate output arises from its definition. That is, the aggregate GDP is defined as the sum of private production and public wages (for similar modelling and findings see Forni et al. (2010), Stahler and Thomas (2012) and Papageorgiou (2014)). Thus an increase in public wages results in an one to one increase in aggregate output. For that reason in Tables 1, 2, 3 we focus on the aggregate effect in gross value added terms when the fiscal instrument under consideration is public wages.
[21]Notice that both type of households have members that work in the public sector.

previous spending instruments, as can be inferred from the prolonged real exchange rate appreciation and the associated decline in Irish exports. The negative effect on the Irish trade balance is more prolonged and deeper which negatively affects the production in the tradable sector.

[Figure 3 here]

4.2.Tax cuts

In this section we turn to the dynamic effects on the Irish economy of temporary discretionary fiscal changes in tax instruments, namely consumption, capital and labour tax. Figure 4 depicts the effects on the Irish macroeconomic variables of a fiscal shock on consumption tax. A temporary decrease in the consumption tax rate makes consumption purchases relatively cheaper, thus both types of households increase current consumption. Due to reasons explained above, the increase in consumption of "Non-Savers" is larger in magnitude. However, increasing private consumption puts upward pressures on domestic factor and product prices leading to a deterioration in the Irish terms of trade and a reduction in exports. In other words, a cut in consumption tax is similar to an increase in government consumption, i.e. crowds out exports and crowds in imports. The trade balance deteriorates and the tradable sector temporarily shrinks. As above, any increase in GDP stems solely from the increase in the non-tradable production and at the same time crowds out private investment, hours worked and production in the tradable sector.

[Figure 4 here]

Figure 5 summarizes the dynamic response of the Irish economy to a temporary discretionary decrease in the capital tax rate. Cuts in capital taxes fuel private investment in both sectors, however this increase takes more time to materialize and is more prolonged in the tradable sector due to the capital intensity of this sector (e.g. compare the impulse responses of investment in the two sectors). On the other hand, in the labour intensive non-tradable sector the increase in investment contemporaneously increases hours worked and as a result non-tradable production rises on impact.

Capital tax cuts can have significant positive effects on the international competitiveness of the Irish economy. In particular, Figure 5 shows that a decrease in capital tax rate causes a long lasting improvement in the Irish terms of trade vis-à-vis the rest of world and a real exchange rate depreciation. Although the terms of trade increases on impact due to the sluggish price adjustment then experiences a prolonged reduction. This is accompanied by a similar dynamic response of the Irish exports, i.e. decrease on impact but afterwards persistently increase. Thus, although the trade balance decreases (as in all other fiscal shocks due to the reliance of the Irish economy on imports) in that case this reduction is smaller than when the fiscal stimulus is implemented via spending instruments. Finally, cuts in capital

taxes induce a direct and prolonged increase in the disposable income of "Savers" (recall that they earn capital income); whereas they increase only temporarily the labour income of "non-Savers" because private wages in both sectors increase. As is apparent, the effect on “Savers” consumption is smaller on impact but lasts longer as "Savers" can save/invest part of the current increase in their disposable income and use it to retain a higher level of consumption over longer horizon. The effect on “non-Savers” consumption is larger on impact and short-lived.

[Figure 5 here]

Figure 6 presents the impulse responses of the key Irish macroeconomic variables to a temporary discretionary decrease in labour taxes. Reductions in labour taxes induce a positive wealth effect on both type of households which increase their current consumption. In addition, the lower labour tax leads to an increase in the after tax wage that households receive in all sectors[22], and incentivize them to substitute leisure with hours worked (this is the intra-temporal substitution effect). The increased labour supply in both sectors leads to lower equilibrium wages which also exerts downward pressure on the returns to capital and marginal costs. Equilibrium factor prices fall and as a result the international competitiveness of the Irish economy improves. This is reflected in the dynamic path of the terms of trade and the associated increase in exports.

[Figure 6 here]

5. Robustness analysis

In this section, we perform a robustness analysis along two dimensions of the model that determine the size of fiscal multipliers. First, we conduct a sensitivity analysis with respect to key structural parameters of the model. In doing so, we focus on parameters that are required to replicate some key structural characteristics of the Irish economy and have quantitatively significant effects on fiscal multipliers, e.g. the degree of openness and the sensitivity of sovereign premia to public debt dynamics. Second, we consider alternative fiscal financing scenarios, namely a spending- and a tax-financed budget neutral fiscal stimulus and compare them with our main fiscal scenario.

[22]Although pre-tax wages fall in Figure 6, after tax wages increase due to the decrease in labour tax. The same holds for after tax public wage.

5.1.Degree of openness

One of the most important structural characteristics of the Irish economy is its exceptional open nature (see e.g. McQuinn and Varthalitis (2019)). In particular, Ireland is among the most open economies globally. This translates to the following characteristics: (i) a larger share of tradable vis-à-vis the non-tradable sector, (ii) reliance on imports both for production and consumption, and (iii) an export-oriented tradable sector, meaning that the larger the share of gross value added produced in this sector is exported to the rest of the world while domestic absorption of tradable goods by Irish residents is much smaller. These Ireland's specific characteristics are expected to affect qualitatively and quantitatively the size of fiscal multipliers.

To understand the significance of Ireland's openness on our results we perform sensitivity analysis with respect to two key structural parameters that determine the degree of openness. In particular, we vary the parameters that govern (i) the long run share of tradable vis-à-vis the non-tradable production (i.e. the size of each sector); and (ii) the long run share of intermediate imported vis-à-vis domestic goods used in the domestic production and the share of the tradable production that is exported to the rest of the world (i.e. the size of imports and exports).

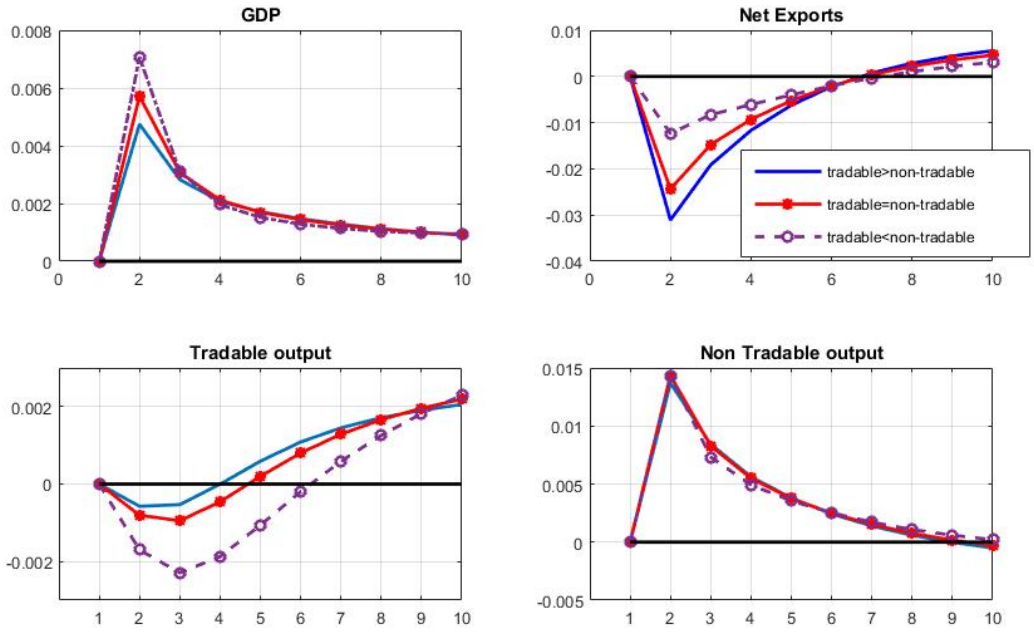
We start our sensitivity analysis with the parameter that governs the size of the two sectors in the economy (tradable vs non-tradable). The value calibrated using Irish data results in an economy in which the tradable sector is much larger than the non-tradable sector. To shed light on the role of this structural characteristic, we compare results from this economy with results from two alternative economies with different structure. The latter two economies differ in their sectoral decomposition of total output. In particular, we recalibrate the associated parameter so as to solve, first for an economy with balanced tradable and non-tradable sectors, and second for an economy with a relatively larger non-tradable sector than tradable sector. Then, we simulate an increase in government consumption as in section 4 and compare the effects on key macroeconomic variables across these three economies. Results are presented in Figure 7.

Figure 7 presents the impulse response functions of GDP, net exports, tradable and non-tradable output to a temporary discretionary fiscal shock in government consumption for these three different economies. In particular, the blue lines presents simulations from the calibration based on Irish data. That is an economy in which the tradable sector is larger than the non-tradable sector. Second, the red circled lines simulate an economy where the tradable and non-tradable sector are balanced. This means the share of the tradable sector is equal to the share of the non-tradable sector. Third, purple dashed lines simulate an economy which relies relatively more on the non-tradable sector. That is an economy with a larger share of the non-tradable sector vis-à-vis the tradable sector.

Results in Figure 7 suggest that the GDP multiplier is smaller when the economy relies relatively more on the tradable sector (compare the blue lines with the red and purple lines). The calibration based on Irish data (blue lines) delivers the smallest output response which is consistent with the very open nature of the Irish economy. The logic of this result is that the

fiscal stimulus is crowding out exports and crowding in imports. The reduction in net exports is larger in the economy that mimics Ireland (see blue line). This causes a contraction in the tradable sector (especially when this sector is export-oriented as in the Irish case – see next paragraph). On the other hand, the differences in the non-tradable sector are infinitesimal across the three economies (see non-tradable output).

Figure 7: The importance of the composition of output (Tradable/non-Tradable)



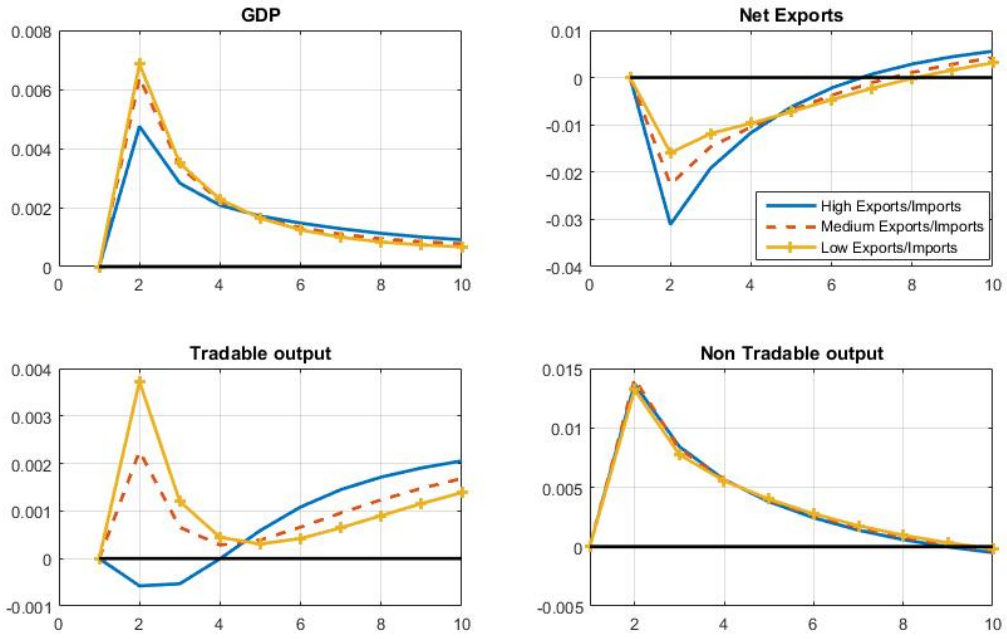
Ireland's tradable sector heavily depends on imported goods while the value added is mostly exported to the rest of the world. This structural characteristic also reflects Ireland's remarkable trade openness. Thus, to further explore the degree of openness channel on spending multipliers, Figure 8 depicts the associated impulse response functions to a government consumption shock (as in section 4) when we vary the structural parameter that governs the share of imported goods used in the domestic production and the share of domestic tradable goods which are exported to the rest of the world. As above, we simulate the model for three different economies. This allows us to compute the effect of fiscal stimulus in economies with lower degrees of export- and import-reliance of the tradable sector than Ireland.

In particular, in Figure 8, the blue lines represent simulations from the calibration based on Irish data. That is an economy in which the largest share of domestic tradable production is

exported to the rest of the world while at the same time domestic investment and consumption heavily depends on imported goods (this economy is labelled as High Exports/Imports in Figure 8). The red dashed lines and yellow crossed lines depicts simulations from economies where the tradable sector is less export-oriented and at the same time domestic production relies less on imports (these economies are labelled as medium and low Exports/Imports respectively).

Results in Figure 8 indicate that the response of GDP to a spending increase is much lower in the Irish economy. This happens because the Irish tradable sector relies heavily on imports while the tradable goods produced are mostly exported to the rest of the world. The economic intuition is as above, government consumption stimulates domestic demand while as indicated above crowds out net exports. Similarly with figure 7, net exports (blue line) decrease more in the case of Ireland. Comparing the responses of the tradable and non-tradable output across the three economies, we can infer that any difference in the size of GDP multiplier can be solely attributed to the different response of the tradable sector. The higher the degree of reliance on exports and imports of the tradable sector the smaller the size of the multiplier.

Figure 8: The importance of the export/import-orientation of the Irish economy



5.2.Sensitivity of sovereign risk premia to debt dynamics

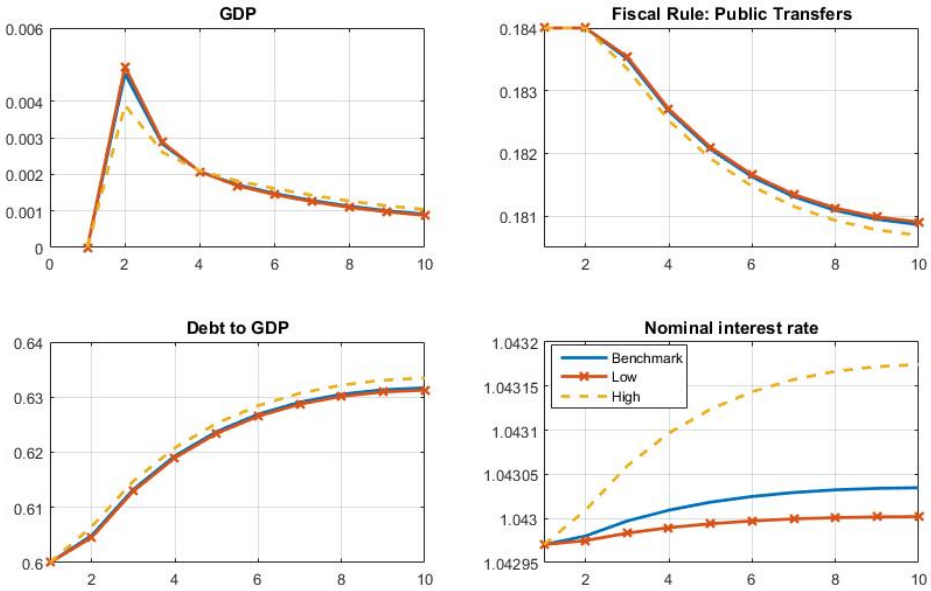
Ireland has exited a programme of financial support in which it originally entered due to unsustainable public debt dynamics and high sovereign premia. Over 2010-2013 the Irish sovereign risk premia rose sharply. In light of this economic environment, the effect of the fiscal stimulus on public debt dynamics and sovereign premia is expected to play a key role on the size of output multiplier. To illustrate this, Figure 9 presents the results of a sensitivity analysis with respect to the parameter that governs the elasticity of the nominal interest rate,

at which Ireland borrows from the international capital markets, to deviations of the public debt to output ratio from a threshold value. Similarly with previous sections, we compare a calibration based on Irish data with two alternative economies. In the latter economies the elasticity of nominal international rate to debt dynamics is either higher or lower. A higher (lower) value of this parameter implies that Ireland's sovereign premia are more (less) elastic to public deviations from its threshold value, , and thus rise more (less) when public debt increases.

In this section, we simulate a fiscal stimulus scenario implemented via an increase in government consumption as in section 4. In particular, in Figure 9 the blue lines represent simulations of the benchmark calibration, the red crossed lines represent simulations from an economy in which the nominal interest rate at which Ireland borrows from the international financial markets is less elastic to public debt. Finally, the yellow dashed lines represent simulations from an economy in which the international nominal interest rate is relatively more elastic to Ireland's public debt (see the dynamic path of the nominal interest rate).

Our results indicate that a relatively more elastic nominal interest rate to debt dynamics will result in a sharper increase in Ireland's sovereign premia (compare the yellow dashed line with the blue and red crossed line). Thus, fiscal stimulus will entail a higher cost of international borrowing (i.e. higher nominal rates) and this will increase the crowding out channel and, as a result, will reduce the size of the output multiplier.

Figure 9: Sensitivity of sovereign risk premia to debt dynamics



Notes: GDP is presented in percentage deviations from its pre stimulus value;

Public transfers and debt-to-GDP ratio are in percentage points; the nominal interest rate is in gross terms.

5.3.Method of fiscal financing

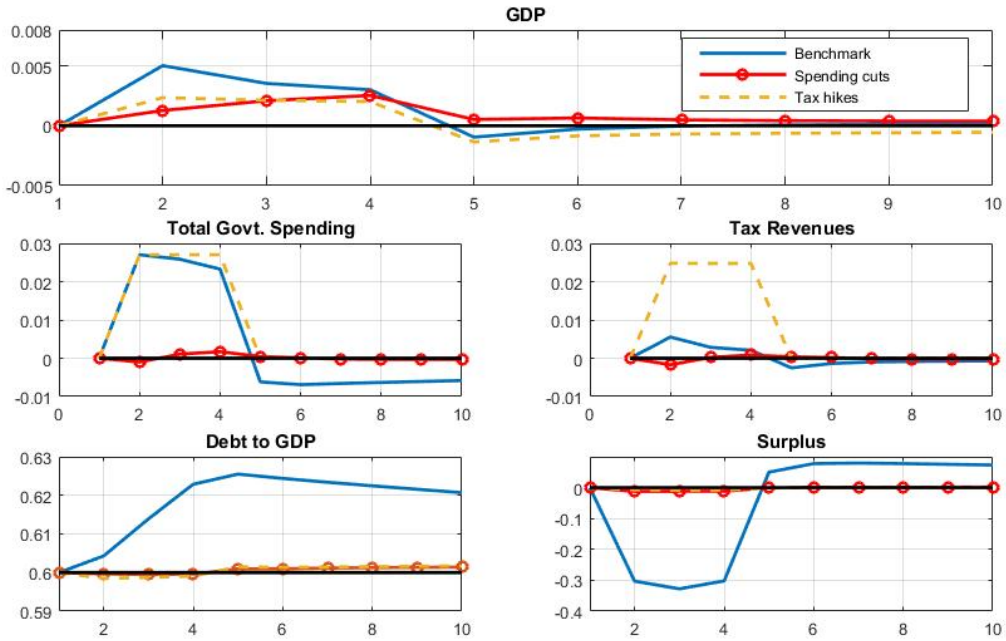
So far we assume that fiscal stimulus is financed by a gradual decrease in total public transfers and a mild increase in government debt while all the remaining fiscal instruments remain constant at their historical data averages. Public transfers are the least distortionary fiscal instrument and thus allows us to quantify the full effect on GDP of each fiscal instrument. However, as pointed out in e.g. Leeper (2010), the size of multipliers depends on the method of fiscal financing. To understand this, in this section we compare three different fiscal financing scenarios of an increase in government spending. For space reasons, we focus only on a government consumption increase (see Hickey et al. (2018) for the implications of a budget neutral prolonged increase in public investment). In particular we assume that a three year increase of government consumption is financed: (i) via borrowing and gradual reduction of public transfers (see blue lines in Figure 10); (ii) via cuts in other spending instruments (see red circled lines); (iii) via increases in taxes (see yellow dashed lines). The latter two scenarios are of particular relevance since they constitute budget neutral fiscal changes. In other words, they do not cause any additional deficit and thus they do not increase debt to GDP ratio.

The top panel of Figure 10 depicts the dynamic response of GDP, total government spending, tax revenues, debt to GDP ratio and surplus/deficit under the three different financing scenarios. All variables are expressed in percentage deviations from their pre-stimulus value except from debt which is expressed as a share of GDP.

As can be seen in Figure 10, in the spending-financed scenario, the increase in government consumption is budget neutral and is financed through a decrease in government investment. Thus, total government spending remains constant so the deficit/surplus and public debt remain unchanged (see the red circled lines in Figure 10). Similarly, in the tax-financed scenario, the increase in government consumption is again budget neutral but now is financed through an increase in tax revenues. In this case, total government spending increases but at the same time tax revenues (see the yellow dashed line) increase by the same amount to finance the increase in government spending. Thus, the deficit/surplus and public debt remain constant.

Focusing on the size of the output multiplier, we find in the top panel of Figure 10 that the main fiscal scenario yields the larger multiplier in the first period. While a fiscal stimulus financed through spending cuts or tax hikes mitigates the stimulative effects of an expansion in government consumption (compare the response of GDP, blue lines with red/circled and yellow/dashed lines). In addition, although tax hikes are temporary and tax rates return back to pre-stimulus values after three years, the effect on output over longer horizons is negative. Using taxes (especially distortionary income taxes) to finance fiscal expansions induces negative supply-side effects which dampen the effect of spending stimulus over the longer run. These findings are consistent with similar studies that estimate negative fiscal multipliers over the long run when fiscal stimulus is financed through taxes (see e.g. Zubairy (2014)).

Figure 10: Alternative fiscal financing schemes



6. Conclusions

This article quantifies fiscal multipliers in Ireland and analyses the transmission mechanism through which Irish fiscal policy affects the economy. We find that in the Irish economy fiscal multipliers are smaller in magnitude than most EU countries due to its degree of openness and the large influence of the tradable sector. Fiscal policy changes result in changes in the composition of GDP and the external balance of the Irish economy. A fiscal stimulus is likely to augment the non-tradable sector vis-à-vis the tradable sector. A fiscal expansion via expenditures may negatively impact on the Irish external balance by causing a deterioration in Irish competitiveness; while a fiscal expansion via income tax cuts may have a smaller effect on the Irish external balance as productions costs and prices are likely to be reduced. This improves the competitiveness of the Irish economy and results in long lasting effects on GDP. In terms of the effect on GDP in the first year, the most effective Irish fiscal instruments are as follows: public investment, government consumption, consumption taxes, capital taxes, public transfers, public wages and, finally, labour taxes. The method of fiscal financing is crucial for the efficacy of a fiscal stimulus. A spending stimulus financed via tax increases mitigates the positive effect on GDP.

7. References

Barrell, R., D. Holland and I. Hurst (2012). Fiscal multipliers and prospects for consolidation. *OECD Journal: Economic Studies*, Vol. 2012/1.

Barry F. and Bergin A. (2012). Inward Investment and Irish Exports over the Recession and Beyond. *The World Economy*, pp. 1292-1303.

Barry F. and Bergin A. (2016). Business. In: *Austerity and Recovery in Ireland: Europe's Poster Child and the Great Recession*. Ed: W. Roche, P.J. O'Connell and A. Prothero.

Batini N., Eyraud L., Forni. L, Weber A. (2014). Fiscal Multipliers: Size, Determinants, and Use in Macroeconomic Projections. IMF Technical Notes and Manuals 14/04, International Monetary Fund.

Benetrix A. and Lane P. (2010). Fiscal shocks and the Sectoral Composition of Output. *Open Economies Review*, 21, 335-350.

Bergin A., Conefrey T., FitzGerald J., Kearney I. and Znuderl N. (2013). The HERMES-13 macroeconomic model of the Irish economy. *ESRI Working paper No. 460*.

Céspedes L.F., Fornero J., and Galí J., (2012). Non-Ricardian Aspects of Fiscal Policy in Chile. *Working Papers Central Bank of Chile 663*, Central Bank of Chile.

Christiano L., Eichenbaum M. and Trabandt M. (2018). On DSGE models. *Journal of Economic Perspectives*, vol. 32, No. 3, pp. 113-40.

Clancy D., P. Jacquinot and M. Lozej (2016). Government expenditure composition and fiscal policy spillovers in small open economies within monetary union. *Journal of Macroeconomics,* 48, pp. 305-326.

Gali J., Valles J., and David Lopez-Salido J., (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, vol. 5 (1), 227-270.

Hickey R., Lozej M. and Smyth D., (2018). Irish Government Investment, Financing and the Public Capital Stock. *Quarterly Bulletin Articles*, Central Bank of Ireland, pages 64-76

Ivory K., E. Casey and N. Conroy (2019). Ireland's Spending Multipliers. *IFAC Working Paper No. 8*.

Lane P. (2010). External Imbalances and Fiscal Policy. *The Institute for International Integration Studies Discussion Paper Series*.

Larch M. Malzubris J. and Santacrose S. (2016). Fiscal consolidation in Ireland: Recent Successes and Remaining Challenges. *European Economy Economic Brief 001*.

Leeper E. (2010). Monetary science, Fiscal Alchemy. NBER working papers 16510

Leeper E., Traum N., and Walker T., (2017). Clearing up the Fiscal Multiplier Morass.

American Economic Review, vol. 17, No. 8.

McCarthy J. (2015). Fiscal consolidation and structural reforms – the Irish perspective. Presentation to the German Finance Ministry conference, Berlin.

Monacelli T. and Perotti R. (2010). Fiscal Policy, the Real Exchange Rate and traded goods. *The Economic Journal*, vol. 120, no. 544, 2010, pp. 437–461.

McQuinn K., and Varthalitis P., (2019). How openness to trade rescued the Irish economy. *In: Structural Reforms and Economic Growth in Europe. N. Campos, P.D. Grawe and Y. Ji (eds), Cambridge University Press* (forthcoming).

Papageorgiou D. (2014). BoGGEM: A dynamic stochastic general equilibrium model for policy simulations. *Bank of Greece*, working paper 182.

Varthalitis P. (2019). FIR-GEM: A SOE-DSGE model for fiscal policy analysis in Ireland. *ESRI working paper*.

Zubairy S. (2014). On Fiscal Multipliers. Estimates from a medium scale DSGE model. *International Economic Review*, vol. 55, pp. 169-195.

8. Appendix A: Figures

Figure 1: Dynamic responses to a government spending increase

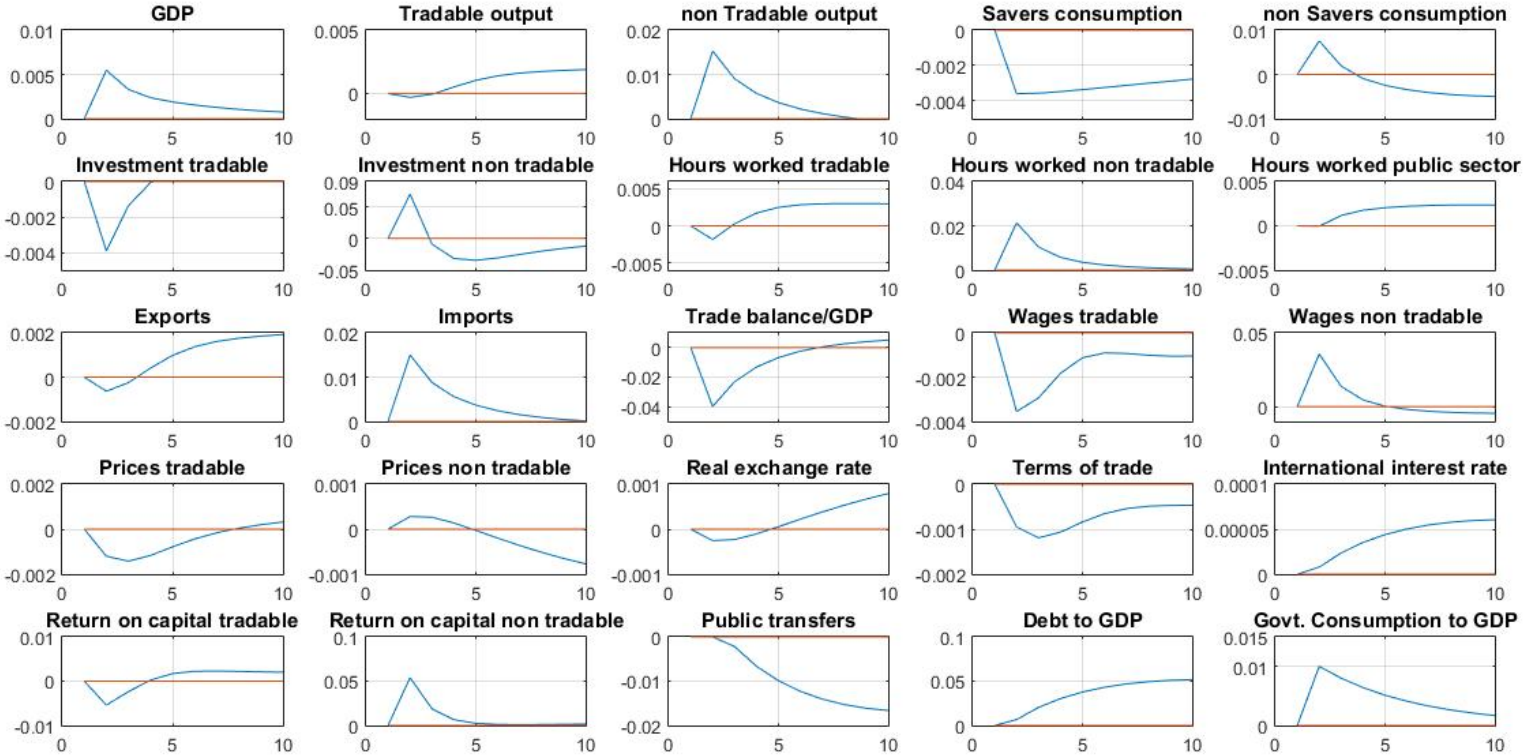


Figure 2: Dynamic responses to a government investment increase

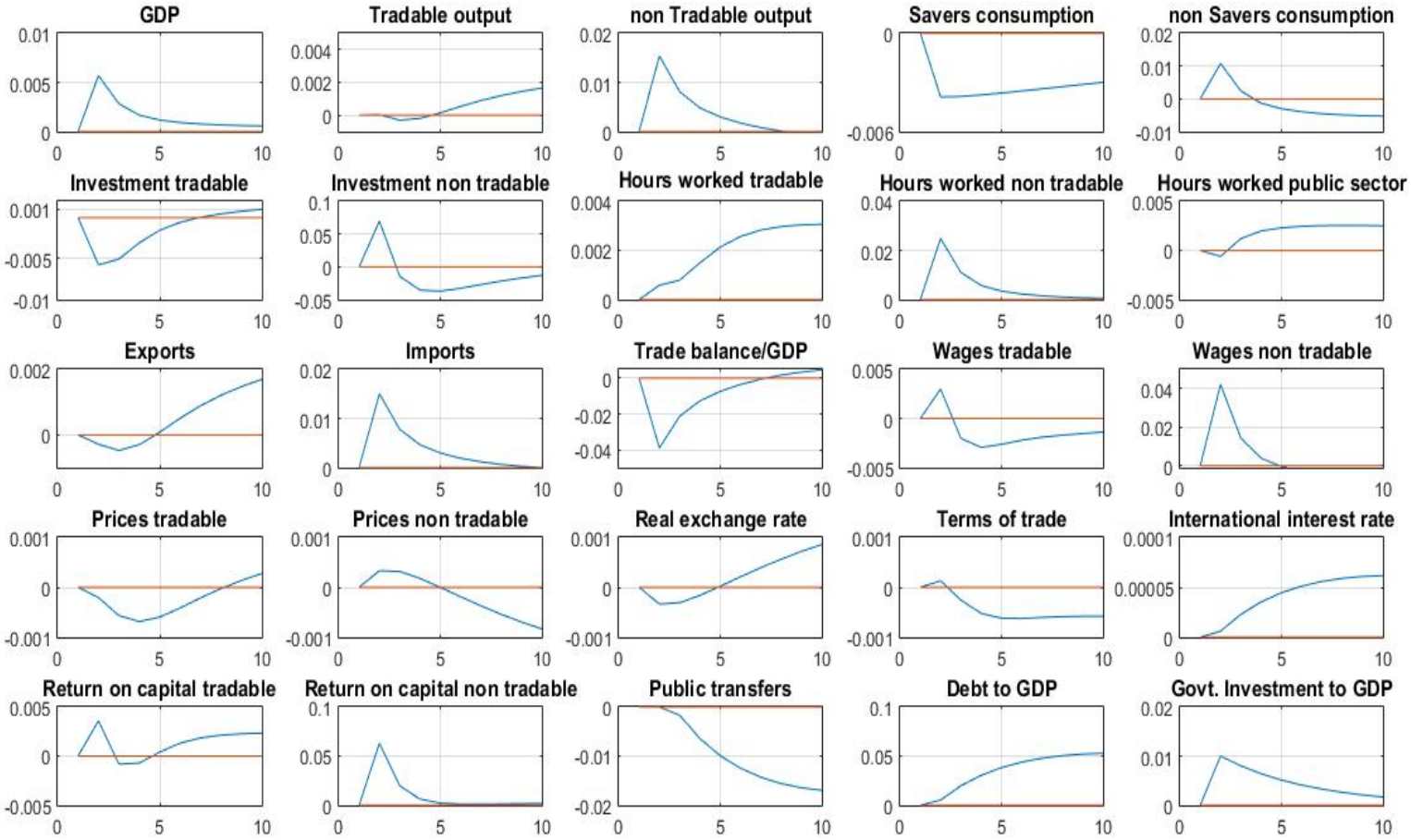


Figure 3: Dynamic responses to public wage increase

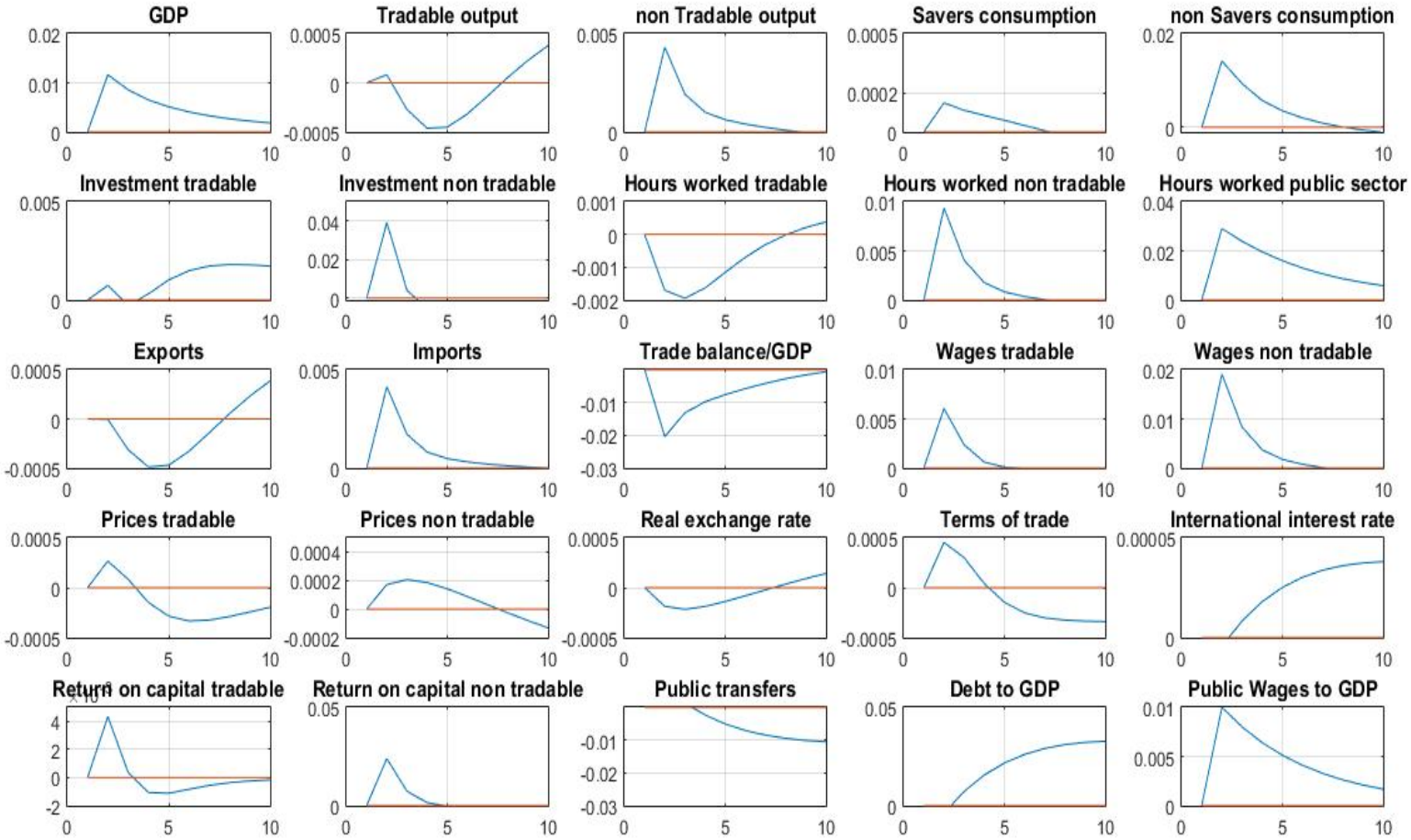


Figure 4: Dynamic responses to a consumption tax cut

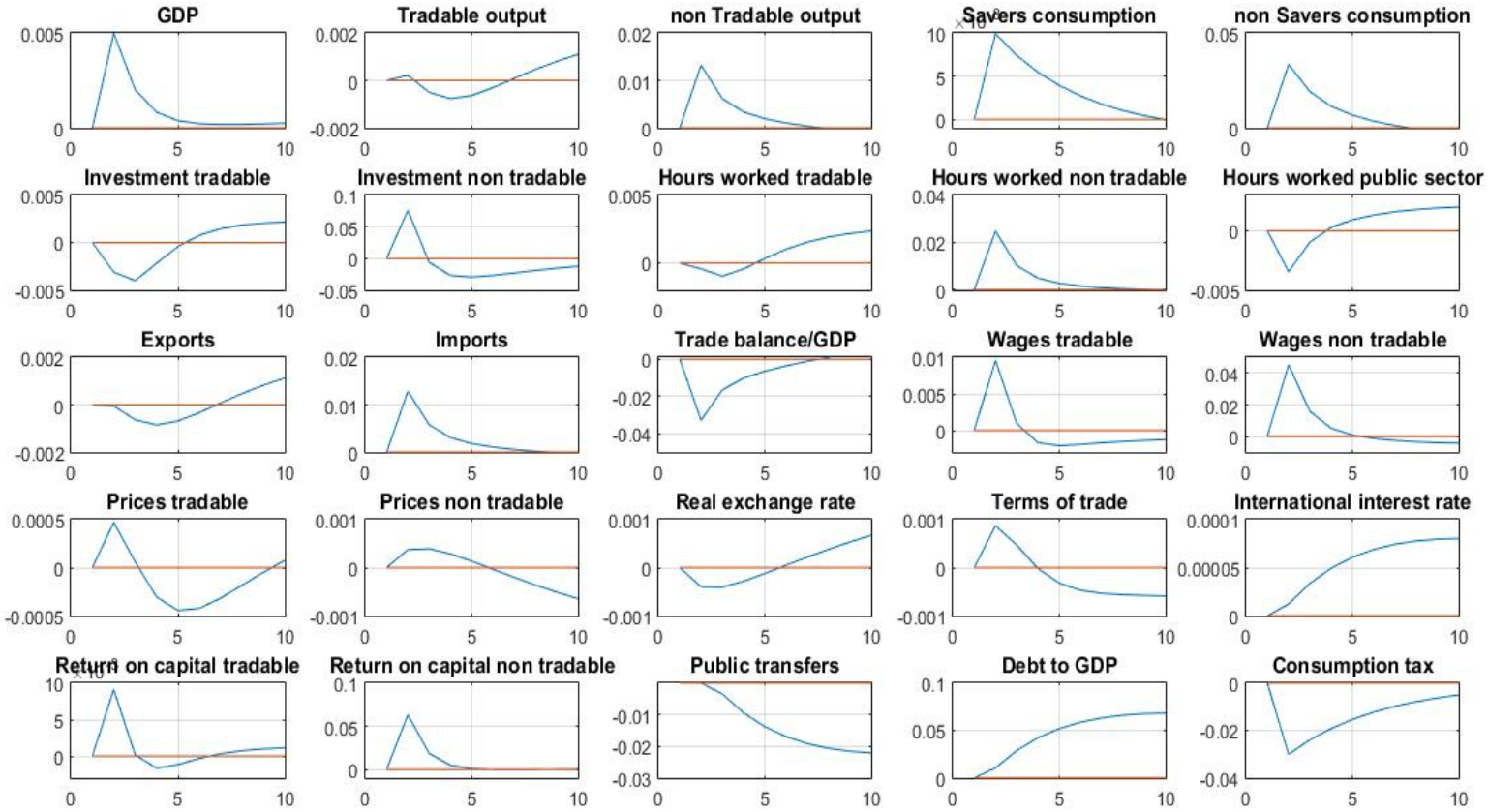


Figure 5: Dynamic responses to a capital tax cut

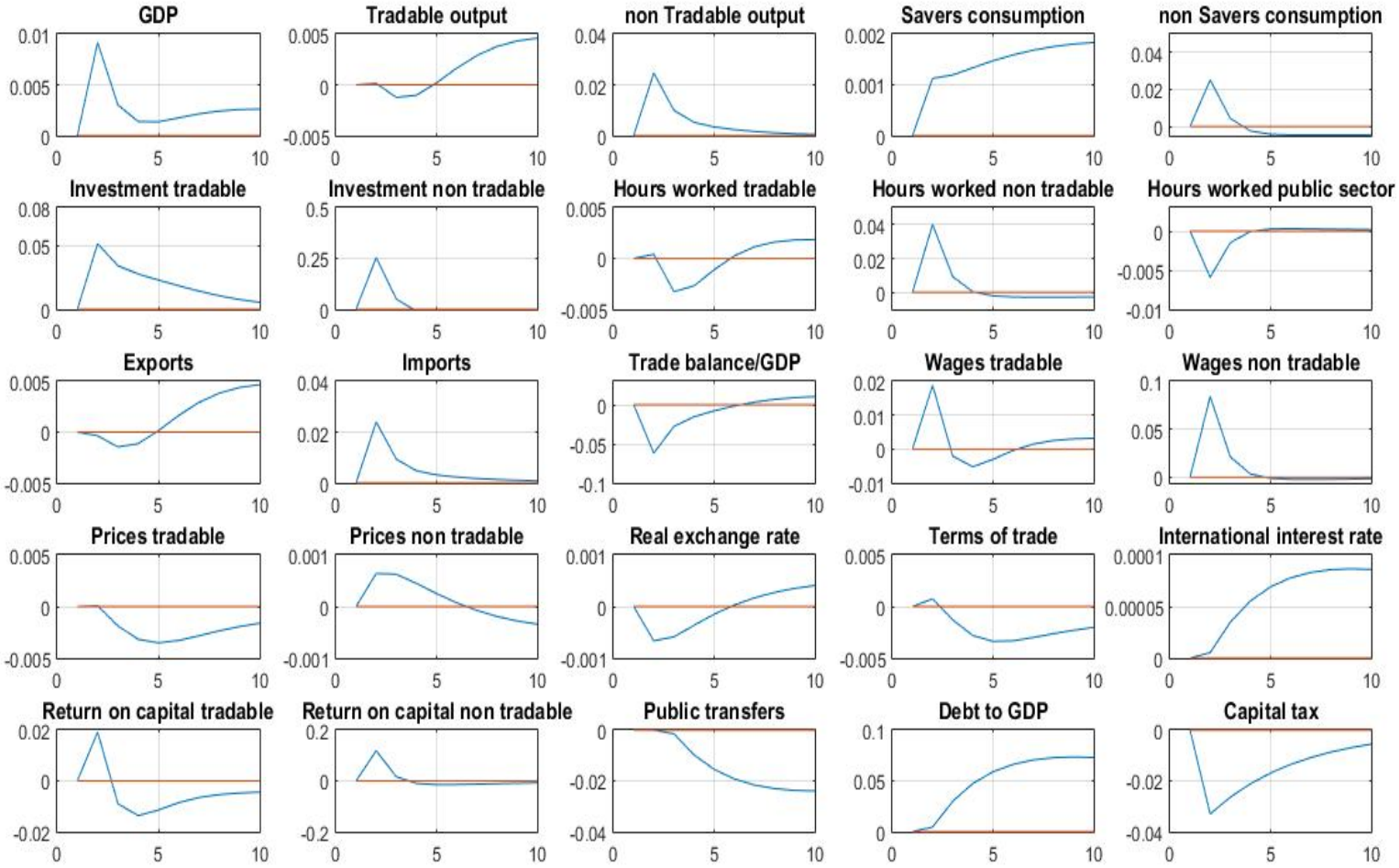
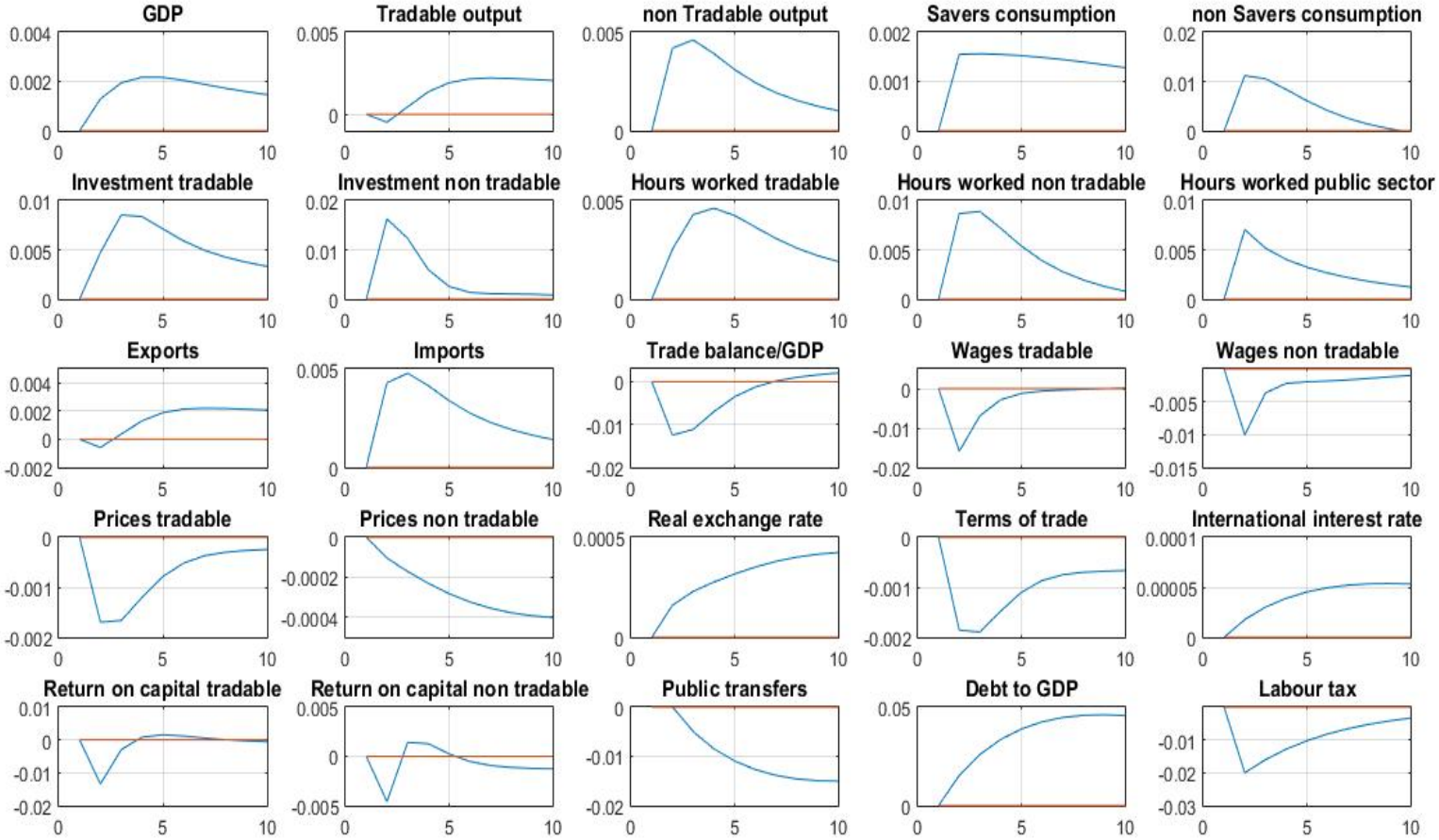


Figure 6: Dynamic responses to a labour tax cut



9. Appendix B: Comparison of the Irish multipliers across models and methodologies

Table 4: First year Irish output multiplier					
Fiscal Instrument	FIR-GEM	HERMES-13	EAGLE	Barell et al. (2012)	Ivory et al. (2019)
Gov. consumption	0.59	-	1.9	0.33	0.5-1
Gov. investment	0.62	0.6	0.8	-	1.2-2.5
Public wages	0.16	0.3	-	-	-0.2-1.2
Public transfers	0.24	0.4	-	0.09	-
Consumption tax	0.51	-	-	0.07	-
Capital tax	0.44	0.4	-	0.08	-
Labour tax	0.09		-		-
Note: HERMES-13 and Barrell et al. (2012) compute income tax multipliers; thus do not distinguish between capital and labour tax.					

10. Appendix C: Comparison of short run fiscal multipliers across a select of Euro Area Countries

Kilponen at al. (2015) employ fifteen dynamic macroeconomic models maintained within the European System of Central Banks to assess the size of fiscal multipliers in European countries. Note that they focus on a fiscal contraction, i.e. a decrease in government consumption and increase in tax rates, thus their multipliers are negative. Comparison of fiscal multipliers across countries and models in Table 5 is only indicative and should be treated with caution. Any differences can be attributed not only to the country specific characteristics but also to different modelling assumptions and specifications as well as the underlying fiscal scenarios.

Table 5: First year output multiplier across a select of Euro Area countries							
Fiscal Instrument	Ireland (FIR-GEM)	Euro area	Finland	Belgium	Greece	Portugal	Malta
Gov. consumption	0.59	-0.98	-0.78	-0.93	-0.9	-0.76	-0.73
Gov. investment	0.62	n/a	n/a	n/a	n/a	n/a	n/a
Public wages	0.16	n/a	n/a	n/a	n/a	n/a	n/a
Public transfers	0.24	n/a	n/a	n/a	n/a	n/a	n/a
Consumption tax	0.51	-0.48	-0.72	-0.19	-0.48	-0.49	-0.15
Capital tax	0.44	-0.12	-0.1	-0.06	-0.65	-0.1	-0.02
Labour tax	0.09	-0.11	-0.1	-0.04	-0.5	-0.51	-0.09
Note: Output multipliers for Euro area, Belgium, Greece, Portugal and Malta are from Kilponen et al. (2015)							